Numerical and analogue models of lithosphere dynamics

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Modelling dynamic processes on the scale of the crust and lithosphere poses challenges related to the simulation of elastic, non-linear viscous and brittle material behaviour, the ability to achieve large deformations for high resolution, accurate quantification and visualisation, the simulation of sedimentation and erosion, and the representation of the interaction with the underlying mantle. Many of these challenges apply to both numerical and analogue (laboratory) models of lithospheric processes. Numerical and analogue methods are often used separately, but an increasing number of studies utilise the partly complimentary nature of both modelling techniques. The strengths of numerical models lie in the easy quantification and visualisation of results, the large freedom in choice of material properties, boundary conditions and geometries, and the possibility to perform a wide range of sensitivity studies. Some approaches lose accuracy in large deformation (because of remeshing for example) or for high viscosity contrasts. In analogue models, the physics of the process under consideration does not need to be captured in equations. The technique is very suitable for studying the 3D evolution of structures, but limited in temperature-dependent rheologies, phase changes and variations in geometries. It is a challenge to achieve a reasonable level of reproducibility of the experiments. A combination of numerical and analogue models can help to establish robust features of modelling results and thus aid the application of models to natural examples.

In this overview talk, i will discuss analogue and numerical model techniques, show examples of model 'benchmarks' and discuss the strengths and challenges of numerical and analogue models using examples of extension, such as basin formation and shear zone propagation, and convergent processes, such as subduction and fold-and-thrust belt formation.